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ROLE OF PRECISION AND AUTOMATION TECHNIQUES IN DOUBLING THE FARMER'S INCOME

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ABSTRACT

Developing countries have to double their food grain production in order to meet the diet requirement of ever-growing population. The young farming community is showing interest in shifting the agricultural practices from traditional to modern methods due to ever declining labor availability and escalating labor wages. The rapid urbanization is forcing rural unemployed youths to migrate to the urban areas in search of their livelihood. The lower prices of agriculture commodity are leading to the degraded standards of the farming community. In this context, to improve the standards of farmer's, traditional systems need to be replaced with timely and efficient modern automation systems which overcome many drawbacks such as inappropriate land development and irrigation practice, improper methods of input application, improper spraying and ineffective crop harvesting-cum processing methods. Today, there is a dire need of addressing the issues like harvesting losses of crops and loss due to disease infestation. In order to tide over this situation, techniques like yield monitoring, variable rate inputs application technology and machine vision are very essential in current agriculture. Automation has been proven technology in terms of improving the food production levels, producing quality products with negligible loss. This paper gives the comprehensive discussion on the various technologies as alternatives to traditional practices of agriculture that could help to achieve timeliness, drudgery less operation with a lower cost of production.

***KEYWORDS:** Automation, Robotics, Laser Land Levelling System & Machine Vision*

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Original Article

INTRODUCTION

Agriculture is among the main pillars of the Indian economy. The agriculture contributed 17.32 percent to India's GDP during 2016-17. Monitoring of environment in agriculture has turned out to be a critical issue in the recent past due to the ever growing population. In order to increase the food grain production to meet the rising population, adoption of automated systems and mechanized options in agriculture is the need of the hour [1]. Automation has replaced most of the manual intervention in various operations of the farm and help increase the efficiency and productivity of farm lands. For the past two decades, the automation has played a key role in the agriculture, but its concept is yet to leave its footprints in agriculture. Automation in agriculture is essential as the world's population is projected to be augmented to 9 billion by 2042. There will be an immense challenge to provide high quality, affordable, safe and nutritious food for such growing population. Traditional practices followed by the farming community has many drawbacks viz. Wastage of inputs resources, improper application of plant protection chemicals to crops, due to which the soil gets degraded and food becomes toxic. Water scarcity in agriculture is another problem and most of the countries are facing water shortage for agriculture and household use as well. In order to tide over the drawbacks of conventional methods, the automation and robotics system is

introduced in the agriculture recent past. These systems have taken over the operations such as pesticide spraying, water supply, seeds sowing and fertilizer application more accurately and precisely. Land levelling in agriculture is one of the laborious and drudgery operations; with the help of automation, it is possible to level the land accurately with less time and resources further, automation techniques are also adopted in seedbed preparation, irrigation, yield monitoring of crops, variable rate fertilizer application, disease monitoring of crops, harvesting and crop handling.

Alongside, the goal of the sustainable agriculture is the production of good-quality food with available raw materials with negligible effects to the environment for providing food for a wide range of consumers. Such being the situation, modern farm machinery must be able to cope up with diverse agricultural processes and execute operations efficiently and eco-friendly as well. The present-day mechanized and automated systems have the capacity to acclimatize to complex agriculture procedures and to execute troublesome activities with high efficiencies. To monitor the performance of such sophisticated and precision machinery, a large amount of information has to be captured by the sensors, stored and transmitted to a data logger for processing. Application of automation systems in farming fetches higher profits by reducing the dependence on manual labor and cost of production, increasing the yield. Though there are improved and automated options in the farming, as on toady various agricultural operations are still handled manually by farm labor challenging the constantly shrinking labor scarcity, tedious and time-consuming operations. In view of this, the present paper provides adequate information about the automation options for various agricultural operations with their productivity and benefits to the farming community in terms of reducing drudgery and enhancing their livelihoods.

CHALLENGES INDIAN AGRICULTURE

Farm Labour Shortage and Wages

In the light of migration of farm labor and rural youths towards urban areas in search of employment poses many circumstances of labor shortage and mounting labor wages. Further, availability of skilled manpower and experienced farm labor in the rural agriculture, families are declining, which in turn forces Agriculture operations to be mechanized.

Climate change

Climate change largely caused by the accumulation of greenhouse gases in the atmosphere resulting in the increased greenhouse effect. Climate change and agriculture are interrelated components, both of which take place on a global scale and their relationship is of particular importance as the imbalance between world population and world food production increases. Based on some projections, changes in temperature, rainfall and severe weather events are expected to reduce crop yield in many regions world (Gornall, et al., 2010). The impact and consequences of climate change for agriculture tend to be more severe in countries with higher initial temperatures, areas with degraded lands (Kean et al., 2009). The practice of agriculture is very different between developing and developed countries, which results in variation of the agricultural contribution to climate change.

Crop Losses during Harvesting

Manual harvesting of fruits and vegetables and field crops accounts to the tune of 30 to 60 percent of the total production costs, with a high net share in the final price of the product. Hence, mechanization of harvest operations, yield auditing and suitable yield monitoring systems to tide over the situation of crop loss during harvesting are essential in today’s agriculture.

Post-Harvest Losses

Post harvest loss includes the food loss across the food supply chain from harvesting to till its consumption [9]. In developing countries, a considerable quantity of produce is lost in post harvest operations due to of a knowledge gap, inadequate technology and lack of cold chain facility. On the contrary, in developed countries, post-harvest losses in the middle stages of the supply chain are moderately low due to the accessibility of superior technology and well-organized crop handling and storage systems. According to one estimate, India incurs losses of about Rs.23000 crores due to post-harvest losses in horticulture produce. To overcome such huge losses, post-harvest unit operations needs to be completely automated.

Lack of Adoption of Novel Techniques of Plant Protection and Site-Specific Nutrient Management

Site-specific nutrient management (SSNM) is an extensively used term in various parts of the world, in general with respect to management of intra field nutrient deficiencies and applying nutrients based on the map based information of deficiency in different locations. The innovative move towards of SSNM involves science-based ideology for guiding the judicious and efficient use of fertilizers as required by crops. It recognizes the intrinsic spatial variability linked tofields during the crop production process and provides a strategy for optimal use of indigenous nutrients. There is a limitation in the adoption of techniques like GPS/remote sensing signatures for on the go and site-specific management of crop nutrients and pest and disease management.

AUTOMATION SYSTEMS FOR AGRICULTURE

Farming today has become more advanced and requires machinery that is capable of performing precise operations. With the existing automation system, the efficiency of machinery and the performance can be enhanced significantly through concurrent and integrated development. Following are some of the potential areas of application automation, which have been discussed in this paper:

- Land development and seedbed preparation
- Variable rate input application
- Automatic Site-Specific Nutrient Management (SSNM)
- Automated-sensor assisted weeding machines
- Automation in Harvesting of fruits and crops
- Automation in Grain Yield Monitoring and Mapping System
- Automated Systems Based on Machine Vision
- Quality inspection of food and agricultural products
- Multiple fruit and vegetable sorting system using machine vision
- Detection of insects with machine vision

Land Development and Seedbed Preparation

Land developers and seedbed preparation are among the highest energy consuming operations in the farming. These operations involve more drudgery and consume more time as well. The land development activities viz. land leveling, scraping, bounding, ridge making and clod crushing are highly essential prior to the final seedbed preparation. The most of farmers in India follow traditional methods for leveling their lands in case of uneven land terrains. The uneven lands are a major problem in agriculture, which leads to uneven water and fertilizer application, also uneven maturing crops. As an outcome, farmers are reporting decreased yields and grain quality, which can be overcome by effective land leveling using a laser-guided land leveler.

Efficient land leveling will advance the water application efficiency, improve crop establishment and decrease irrigation time required and also efforts need to manage crop. Proper land leveling has ensured 25% higher yields [4]. In surface irrigation method, nearly about 20-25% of water losses due to uneven lands and inappropriate farming practices. Thus, low lying areas of the field are over irrigated and high areas are always under-irrigated. In high areas, irrigation water may not reach due to uneven lands which lead to penetration of the unused nutrients into the soil; at the same time, in case of over-irrigation of low lying areas, there will be a major problem of waterlogging. The Laser controlled land leveling technique has been extensively used in the United States and all over the world for the past two decades. Many manufacturers have produced laser leveling systems, but the price is too high to be affordable by the farmers of developing countries. The custom hiring is an alternative solution for accessing the services of laser guided land levelling.

Figure 1: Overview of a Conventional Method of Levelling by Draft Animals

The laser-guided land leveler mainly consists of the tractor, laser transmitter, laser receiver, an electrical control panel, twin solenoid hydraulic control valve and bucket scraper. The laser beam will be transmitted by the transmitter, which in turn intercepted by the laser receiver mounted on the leveling bucket. The control panel on the tractor interprets the signals from the receiver and operates the leveling bucket to cut or fill the soil as per the soft signals of the control panel to the bucket.

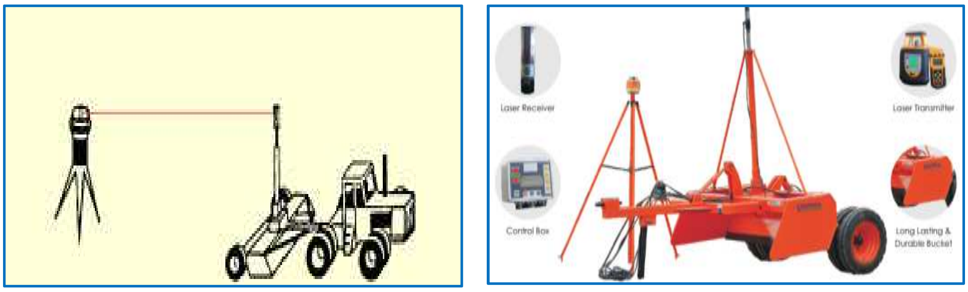

Figure 2: Components of a Laser-Guided Land Leveller

Benefits of Laser Guided Land Leveling

Laser guided land levelling has taken over the conventional methods of land development in terms of their usefulness, effectiveness, advantageus and economy of operation. Besides its usefulness in eliminating the drudgery and providing timeliness of operation, it has got more benefits for farming community:

- Saves 25-30% of irrigation water
- Enhance the crop establishment and improves yield by 15-20 percent
- Reduces weed problems
- Improves uniformity of crop maturity
- Saves the seeds and fertilizer by 20-30 percent
- Reduces the amount of water required for land preparation.

Variable Rate Input Application

For the past 3 decades, the significant improvements in the areas viz, global positioning systems (GPS), microprocessors, controllers, bio-sensors and geographical information systems (GIS) have elated the development of site-specific, variable-rate techniques for precise input application. Parallely, the agricultural production across the world has undergone the changes in technologies that augment the productivity of land, labor and mechanized systems such as tractor auto-guiding. The conjunction of self-driven tractor steering and variable rate technology is more relevant for on the go application of inputs. Using tractor guidance control and variable rate applicators, farmers can increase the efficiency of input application by eliminating swath overlaps in operations. These novel innovations have been adopted by farmers across the various countries for major crops such as corn, wheat and soybeans (Koch and Khosla, 2007). In the recent past, Arizona vegetable producers have become increasingly inclined towards the technologies for variable rate application of soil-applied pre-emergence herbicides.

VRT combines a variable-rate control system with the equipment to apply inputs timely, precise and specific location to achieve application rates. A balance of components, such as a differential global positioning system (DGPS) receiver, control panel, VRA software and controller are integrated to make VRT operational. Three various approaches exist in the VRT implementation: map-based, sensor-based, and manual. In the map-based approach, the inputs are applied as per the prescription map (Figure 3) generated based on soil analysis or other information; then used by the VRT to control the desired application rate within each field zone. This system utilizes sensors to assess crop or field conditions to provide real-time data for VRA of inputs. Manual control may also be used to vary the input application rates with the manual labor responsible for changing the rates on the controller while in operation.

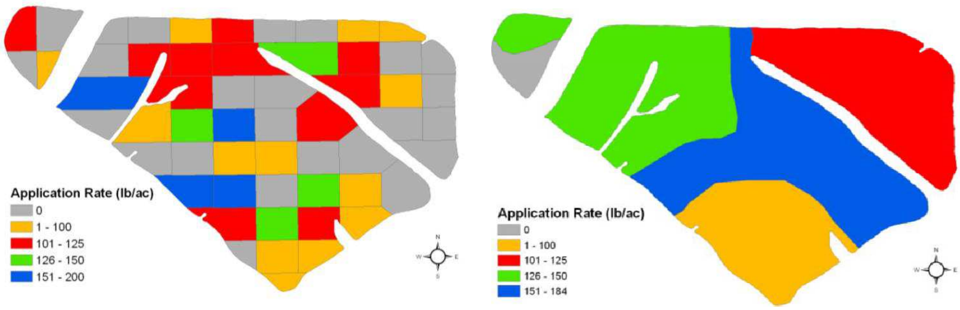

Figure 3: Grid-Based and Zone-Based Prescription Maps

Application of VRT in Various Agricultural Activities

Variable rate technology has a key role in enhancing the input application efficiency and sustainable management of soil resources. It is associated with modern techniques which are integrated with the likes of electronic controls and communication. VRT can be extended to the various activities of crop production as follows:

- Fertilizer and manure application (Macro and Micronutrients)
- Sowing, planting, and transplanting
- Plant protection and spraying (Pesticides, herbicide, insecticides, and fungicides)
- Irrigation

Site-Specific Nutrient Management (SSNM)

Site-Specific Nutrient Management (SSNM) provides sufficient information related to the intra-field variability of nutrients and subsequently ensures the precise nutrient application based on the assessed information. SSNM increases the grain yield by effective and precise fertilizer application. It minimizes the fertilizer overuse and also reduces the greenhouse gas emission to the tune of 50 percent. SSNM consisting of combinations of nutrient management principles, including better crop management techniques which could help farmers to get higher yield and high profitability as well.

- SSNM advances the supply of soil nutrients over space and time to manage yield requirements.
- SSNM help enhance the productivity of crops and effective use of the fertilizer.
- SSNM practices by farmers could help mitigate the GHG emissions.
- Returns to the farming community after implementing the SSNM depends mostly on fertilizer costs.

Recommendation of fertilizer application very often depends on yield response data averaged over large areas with respect to the nutrient application. The demerits of broadcasting and blanket application are much folds due to their uneven distribution of nutrients over the soil surface. To accomplish the balanced or the uniform application of fertilizer and to overcome drawbacks of such methods, an alternative technique SSNM is essential. The main objective of SSNM is to optimize the application of soil nutrients over the time and space to match the requirements of crops through four golden principles of precision agriculture. They are;

- **Right product**: According to crops' requirements and soil type, the fertilizers are used in order to ensure a balanced of supply nutrients.

- **Right rate**: Based on the availability of nutrients in the soil and soil requirements in terms of macro and micronutrients, the fertilizers is applied. The application of fertilizer without prior knowledge about the existing soil nutrient availability leads to leaching and gaseous emissions and wastage of resources.
- **Right time**: Required nutrients are applied to crops based on their crop nutrient dynamics. This is accomplished by split doses of mineral fertilizers or combining organic and mineral nutrient sources to provide slow-releasing sources of nutrients.
- **Right place**: Placing and keeping nutrients at the ideal separation from the crop and soil depth so that crops can use them and minimizing nutrient losses. Generally, incorporating nutrients into the soil is recommended over-applying them to the surface.

Automation in Grain Yield Monitoring and Mapping System

Yield monitors are a recent development in agricultural machinery that allows grain producers to assess the effects of weather, soil properties, and management of grain production. Grain yield monitoring is an excellent tool for monitoring yield in the agriculture field. The yield monitoring is a device which record's the information and determines the grain yield. Automation yield monitoring displays the grain yield, grain moisture, a harvested portion of the field is in user display with the color coded spatial map. The user can extract information to segregate the data and recognize yield information from various patches of the field. The control panel allows the operator to download yield data from the monitor and this can be analyzed for further processing. The grain yield mapping could help display the yield by means of programming. It helps in decision making in respect of fertilizer application rates, seeding population rate and site particular forming and also helps to take a decision on best management practices in terms of comparing crop varieties, fertilizer types and application rates.

Figure 4: Grain Yield Monitoring and Mapping System

Benefits of Yield Monitor

The yield monitor provides the user with an accurate assessment of yield variability within a field. A yield monitor can provide very useful information, help quantify the grain flow in various components and enhance on-farm research. Yield data can be gathered for a specific field, which facilitates the comparative analysis of grain yield in respect of hybrids, varieties and treatments within test plots. For example, all yield monitors can measure grain mass and harvested area on a load-by-load or field-by-field basis. This characteristic allows the worker to get an immediate readout in the field of accumulated grain weight, harvested area and average yield. With a number of yield monitors, these data can be transferred to the personal computer and stored in non-volatile memory for further standard word-processing. When yield data are used with information generated by a Differential Global Positioning System (DGPS) receiver, a producer can generate yield maps that provide a quick visualization of crop performance within a particular crop

production unit. With DGPS, the benefits of using a yield monitor are even more evident. Particular season of crop summaries the harvested areas that can be used for documentation of yield data and preparation of yield map for further assessment of nutrient status, which help in application deficit nutrients to the soil based on map information. With the help of yield map, a farmer can decide the weed management practices and plant protection chemical application.

Yield Monitor Components

Yield monitors are a combination of various components (Figure 5). They include different sensors and other components, including a data storage device, the user interface (display and keypad) and a task computer located in the combine cab which helps to control the integration and interaction of all other components. The sensors quantify the mass or the volume of grain flow through the various components of the combine (grain flow sensors), separator speed, ground speed, grain moisture, and header height. The yield is computed as a function of various crop parameters that are sensed. A grain flow sensor is used to measure the mass or volume of clean grain moving through the separator of a combine. Determination of both separator speed and ground speed is essential for the yield monitoring process. Measuring the moisture content of the grain is very much essential in yield monitoring. Moisture sensors installed at the grain outlets assess the moisture content of grains. Farmers are concerned about the moisture content of grains in respect of harvesting, drying, and storing grain, the cost of drying as well.

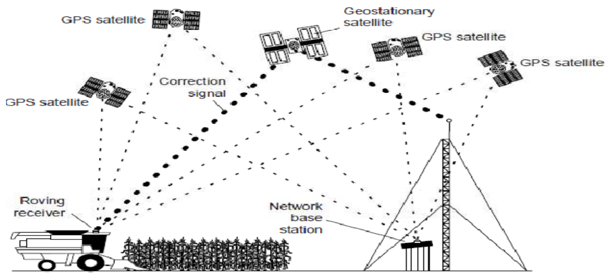

Figure 5: Components of Grain Yield Monitoring System on the Combine

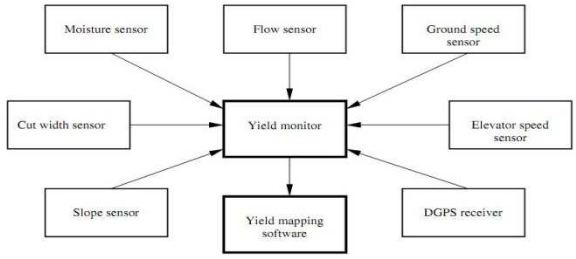

Figure 6: Schematic of Sensors That Transmit Data to Yield Monitor

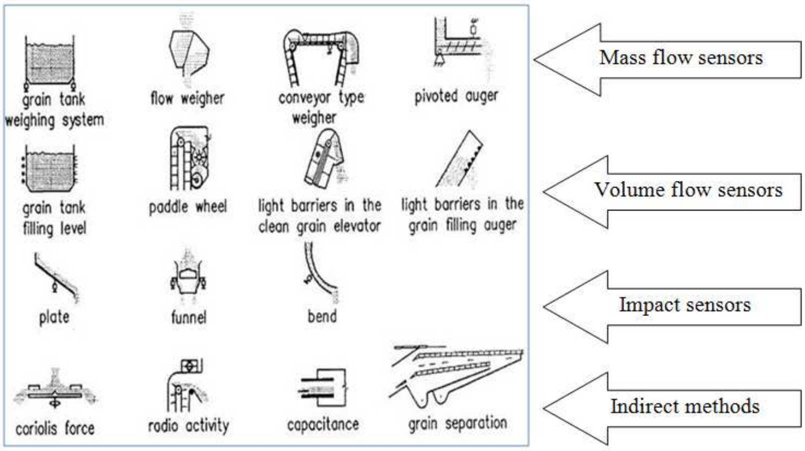

Figure 7: Various Sensors to Monitor Grain Flow

Site Specific Weed Management

Weed management in present day's agriculture is a complex problem. The inter-row weed management can be easily done by either manual or mechanical means, but intra row weed control is challenging one, which is the need of the hour. On the go ground sensors which are mounted on a vehicle or a spray, boom allows real-time weed detection and immediate action of spraying of respective chemicals over the weeds in the field. As and machinery moves over the crops, it's very essential to acquire the information about weed detection and its density to interpret them in real-time spraying. Real-time spraying can be performed at an individual spot in place of uniform test plots over large areas. Weed's varieties vary across the globe, leaving the trend of adoption of a developed weed control machine or spraying machine as per the biometric parameters of weeds and soil.

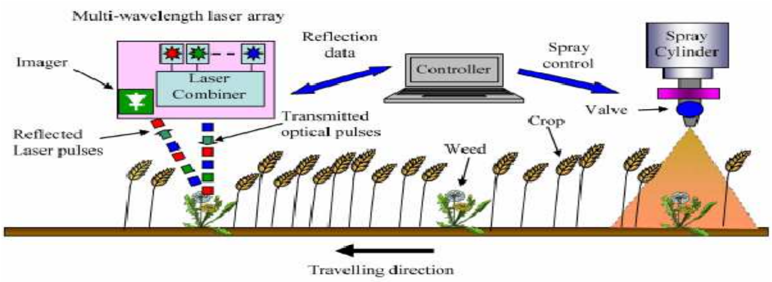

Figure 8: Conceptual View of Real-Time Weed Detection and Spraying (Sahba*et Al*., 2006)

Precision agriculture encourages site-specific crop management (SSCM) to control the inputs to a crop for accounts for the natural variability existing intra field. This also comprehends variation in soil properties, water and fertilizer needs, and crop health. Collectively with yield mapping and spatial information, VRT can deliver the optimum rate of inputs throughout the crop season in order to maximize the farm productivity. Weeds can presently be managed on the go either when there is no crop or using weed maps. An on the ground sensor for weed detection within the crop real-time is a missing piece of technology, which allows VRA of herbicides to weeds where it is needed. This novel technique would ensure significant economic benefit and savings in input cost of spraying chemicals and also an important part of sustainable agricultural practices that increase productivity with minimum or negligible environmental degradation.

Role of Sensors in Automation

For the past 15 years, research has been carried out on yield sensors and focused mainly on the development of reliable grain flow sensors on combining harvest for estimating the grain yield and losses at various grain outlets during harvesting. Researchers have developed sensors for detection of various input parameters, of which few were proved to be relevant for commercial application due to the extremely prerequisite criteria applicable to sensors. They are as follows:

- The sensor should be capable of measuring the grain flow with sufficient accuracy (measurement error is less than 5 percent.)
- The forward movement of the machine and whole body vibrations should not disturb the accuracy of the sensor.
- Analysis of signals to derive at yield maps should be simple and straightforward.
- The accuracy of the sensor must be autonomous for varieties in mass properties.
- Requirements for recalibration and maintenance of the sensor should be less.
- The sensor should have a good design for easy integration in combines.

Robotics in Agriculture

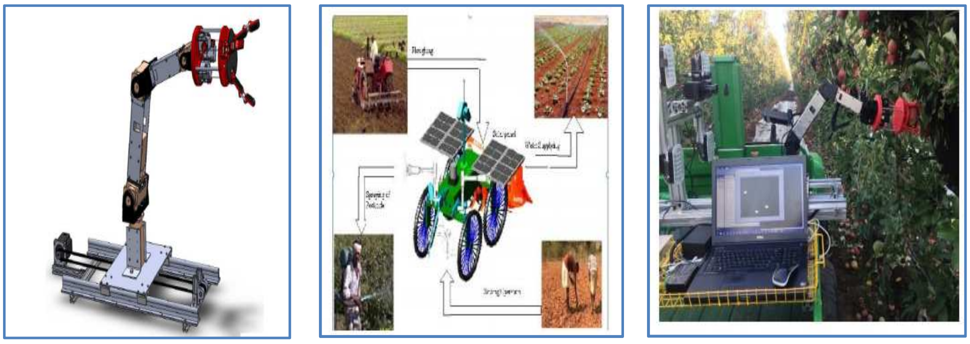

Figure 9: Robotics in Agriculture

Most critical feature in successful agricultural robots is the ability of the robotic system to process sensory information and in particular, their capacity to analyze and interpret visual input. Certainly, the coupling of visual data with machine vision algorithms may make possible numerous operations and advance the agricultural automation to a new generation. However, the challenges coupled with machine vision in severe unhindered environments are countless: objects of various colors, shapes, sizes, textures, and reflectance properties; highly unstructured scenes with high uncertainty; ever-changing illumination and shadow effects on vision. In the machine vision system, pixel properties of fruits or vegetables are assessed by the high-resolution camera, once the RGB image of a particular fruit or vegetable is acquired the image processing is done in different steps. The RGB images then are converted into clear illuminated black and white or greyscale images, removing all other distractions while getting the image. The final target oriented fruits are recognized in the image by pixel segmentation. Detected targets are then used to facilitate the interaction of the fruit with robotic manipulators and end effectors for further handling and physical processing. The main concern of fruit picking robots is that, along with the ripening fruits; the disease affected leaves are also harvested. In several instances, the ripen fruits occluded by the leaves are not harvested leaving the lower efficiency of the system.

Automation in Harvesting

Fruits and vegetables are important sources of food for human diet. Numerous adverse situations occur during mechanical harvesting of fruits and vegetable such as products to be harvested are enormously variable regarding agronomic, physiological, structural characteristics, shape and size, separation and also a breakdown of machines [3]. Specialized harvesting machines or robots are adopted and utilized for minimum hours annually. Fruits and vegetables are yet harvested manually even in developed countries. For adopting the automation and robotic systems in agriculture and horticulture in order to improve the economy and quality of production, several factors need to be considered. Of which, the clear knowledge about the different varieties, agronomic practices, package of the practice year around, scheduling of irrigation and soil management, materials handling, grading and sorting, processing and post-harvest value addition skills need to be considered. In most fruits and vegetable productions, processing plants, the operations such as cleaning, handling and transportation are performed by automated and robotic systems. Each unit operation is well programmed and designed to process and add value to fruits and vegetables in processing units with the help of automation and robots.

Figure 10: Automation in Fruits and Vegetable Harvesting

Automated Systems Based on Machine Vision

Machine Vision (MV) is the process of applying a wide range of techniques and methodology to perform image-based automatic inspection and process control. The actual purpose of machine vision is to measure and make the judgement in work, hence this system replaces the human intervention in operation. It captures the photo by visual sensor and converts into an image signal; in turn, signal is transferred to the image processing depending on the pixel signal distribution and brightness. The processed image signal is converted into a digital signal and is compared with the stored/original data in the database. The machine vision system mainly consisting of lighting source (Halogen light, LED light source, high-frequency fluorescent source, flash source), optical lens (CCT camera, microscope head), cameras, image processors, image video capture card, image processing software, monitors, communication I/O units.

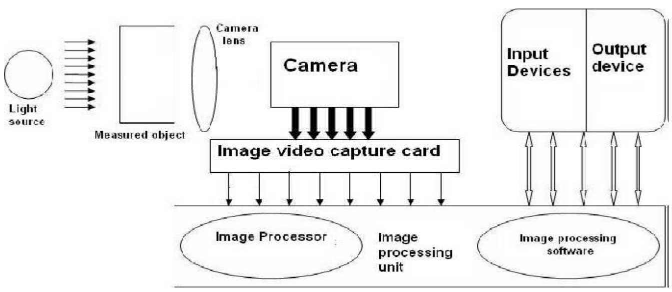

Figure 11: Conceptual Line Diagram of Machine Vision System

Machine vision is one among alternative methods for an automated, non-destructive and cost-effective technique for inspection and grading of vegetables and fruits. Its speed and accuracy always fulfil the ever-increasing in production and product quality requirements consequently, help to attain to totally automated processes. The manual labor service has been the fundamental and crucial element in fruit harvesting and packaging in India. However, the manual hand picking and packaging has few drawbacks such as time inefficiency, repetitiveness etc. Besides this, with escalating labor wages nowadays, it is essential to find the cost-effective, time-productive and timely measures for fruit harvesting and packaging. This can be efficiently done by Machine Vision technology. This is extremely fast, cost-efficient and hygienic technique. The machine vision is extensively used in developed countries for sorting and grading of fruits and vegetables, which will be of a huge benefit. Some of the other benefits of using this system are a more efficient operation, production of more consistent product quality, greater product stability and safety.

In developing countries, farmers and distributors use manual labors for sorting and grading the food product which is a tedious, laborious and ineffective method. Manual sorting and grading are dependent on a conventional visual quality inspection performed by the human operators that make monotonous, tedious, moderate and non- reliable products. A cost-effective, consistent, superior speed and accurate sorting can be achieved by computer vision technique. The image analysis includes image acquisition, image pre-processing and image interpretation the techniques used in the image processing which leading to quantification and classification of images and objects. Physical image sensors are used for image acquisition in order to analyze the image, dedicated computing hardware and software are used. The first parameters identified during the inspection are size, shape and color analysis size, can be estimated using machine vision.

Advantages of Machine Vision

High accuracy: The accuracy of these systems is very high and it performs the operation with high resolution and no error in the system.

Continuity: It performs the operation continues without any interruption where the manual system makes the operation less efficient.

Cost-effective: With the sharp decrease in the cost of the computer processor the visual system operating and maintenance cost is less.

Flexibility: This system performs the variety of measurements. Machine vision frameworks have preferable versatility over optical sensor or machine, with the help of automation system became more flexible and diversity by changing the software. Colour machine vision inspection and grading applications for agricultural products. The color of agricultural products is one of the essential indications of product value. It can give an idea of fruit ripeness, growth, color and luster etc., accurately [6].

CONCLUSIONS

The traditional system of agriculture has several drawbacks such as inappropriate land development, injudicious irrigation, inaccurate and improper manuring, wastage of inputs, improper spraying of pesticides on crops, the indiscriminate use of Agrochemicals and the effects of global warming. In order to tide over the situation the automation and robotics system are essential in the agriculture. The automation systems have an ample opportunity in replacing the

existing and traditional practices such as pesticide spraying, water supply, sowing, manuring, digging, harvesting and fruit picking with higher precision. With the help of precision technology, the most tedious operation like land levelling is feasible with more timeliness to enhance the irrigation efficiency. The seedbed preparation, modern systems like yield monitoring, input application through variable rate technology, disease monitoring of agricultural crops by automation and machine vision, robotic and mechanical intervention in orchard crop harvesting. The Phyto techniques and Mechatronic's find the vast areas of their application in the agriculture and horticulture crops. Hence, it is concluded that as an alternative to the traditional systems, the high efficient automation system can prove timeliness of operation, saves energy and time, and reduces the cost of operations as well. As a whole, implementing the automation system to agriculture, a farmer can overcome the labor shortage and higher production costs; produce quality products and gets maximum returns to improve his standards of living.

REFERENCES

1. *S. S. Katariya, S. S. Gundal, Kanawade M. T and Khan Mazhar, "Automation in agriculture", International Journal of Recent Scientific Research Research, ISSN: 0976-3031, Available Online at http://www.recentscientific.com, Vol. 6, Issue, 6, pp.4453-4456, June 2015*
2. *Doerge, T. (1999). Yield monitoring creates on and off-farm profit opportunity. Crop Insights, Pioneer Hybrid International. 9(14):1-4*
3. *Aishwarya J. Kurhade, Aishwarya M. Deshpande, Ruturaj D. Dongare "Review on "Automation in Fruit Harvesting" ISSN: 2278-621X, an international journal of latest trends in engineering and technology(IJLTET), Vol 6. Issue 2 Nov 2015*
4. *LvQingfei, Liu Gang, "Research on an improved laser controlled land levelling system", in Proc. Eleventh IEEE InternationalConference on Communication Technology, pp. 413-416, Nov. 10- 12, 2008.*
5. *Simon Blackmore, Bill Stout, Maohua Wang and Boris Runov, "Robotic Agriculture The Future of Agricultural Mechanisation", 5th European Conference on Precision Agriculture, Uppsala, Sweden 9-12th June 2005*
6. *Peilin Li, Sang-heon Lee, Hung-Yao Hsu, "Review on fruit harvesting method for potential use of automatic fruit harvesting systems" Michael Hannan, Thomas Burks, "Current Development In Automated Harvesting".*
7. *E. J. Van Henten, J. Hemming, B. A. J. Van Tuijl, J. G. Kornet, J. Meuleman, J. Bontsema And E. A. Van Os, "An Autonomous Robot for Harvesting Cucumbers in Greenhouses".*
8. *Attri, Arnav, Sahil Vashist Shubham, and Gagangeet Singh Aujla. "An Advance Algorithm for Precision Agriculture using Wireless Sensor Network."*
9. *Aulakh J., Regmi A., Fulton J. R., Alexander C. Estimating post-harvest food losses: Developing a consistent global estimation framework; Proceedings of the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting; Washington, DC, USA. 4–6 August 2013.*
10. *Koch, B. and R. Khosla. 2007. The Role of Precision Agriculture in Cropping Systems. J. Crop Prod. 9: 361-381. URL: http://classes.css.wsu.edu/css403/8_PrecisionAg.pdf.*
11. *K. Sahba, S. Askraba, and K. E. Alameh, "Non-contact laser spectroscopy for plant discrimination in terrestrial crop spraying," Opt. Express, vol. 14, pp. 12485-12493, Dec 2006.*